Strait of Georgia Juvenile Herring Survey, September 2013

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Nanaimo, British Columbia
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STRAIT OF GEORGIA JUVENILE HERRING SURVEY, SEPTEMBER 2013

by

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ABSTRACT

Thompson, M., Fort, C., and Boldt, J. 2015. Strait of Georgia juvenile herring survey, September 2013. Can. Manuscr. Rep. Fish. Aquat. Sci. 3072: v + 35 p.

A fall juvenile herring survey of the Strait of Georgia took place in 2013. All forty-eight stations were sampled throughout the Strait of Georgia following the ten core transects that have been sampled since 1990. The survey area extends from Trincomali Channel in the south to Smelt Bay in the north. Plankton tows were performed to determine food organism abundance in the study area.

RESUME

Thompson, M., Fort, C. et Boldt, J. 2015. Relevé du hareng juvénile dans le détroit de Georgie, septembre 2013. Rapp. manus. can. sci. halieut. aquat. 3072: v + 35 p.

Un relevé automnal du hareng juvénile dans le détroit de Georgie a été réalisé en 2013. L'ensemble des 48 stations situées dans le détroit de Georgie ont été échantillonnées en suivant les 10 transects principaux qui font l'objet d'un échantillonnage depuis 1990. La zone du relevé s'étend du chenal Trincomali au sud jusqu'à la baie Smelt au nord. Des traits de plancton ont été effectués afin d'évaluer l'abondance des organismes alimentaires dans la zone à l'étude.

INTRODUCTION

Pacific herring (*Clupea pallasi*) are an important commercial and a vital forage species for many marine mammals, birds and other fish in British Columbia's coastal waters. Herring spawn principally on marine vegetation in the subtidal and upper intertidal zone between February and June, with peak spawning between March and April (Humphreys and Hourston 1978). Larvae hatch in two to three weeks, and disperse with surface currents, metamorphosing into juvenile or young-of-the-year herring at a length of ~25mm (Hourston and Haegele 1980). Herring are considered juveniles or immature until they are about three years of age and have joined the sexually mature spawning population (Hay and McCarter 1999). During daylight hours, juvenile herring congregate in schools, occasionally forming mixed aggregates with other pelagic species, close to shore near the bottom (Haegele 1997). At dusk, these fish migrate into surface waters to feed on plankton. During this time they are vulnerable to purse seine gear.

Purse seine surveys to determine the distribution and abundance of juvenile herring in the Strait of Georgia have been conducted annually since 1990, except for 1995 (Figure 1). The main objective of the survey was to estimate the density and relative abundance of the juvenile herring population as a potential indicator of recruitment before they have joined the spawning stock (Schweigert et. al. 2009). In addition to recruitment prediction, the surveys have contributed to a better understanding of the distribution, abundance, and ecological role of herring in the Strait of Georgia.

METHODS

The annual survey of juvenile herring in the Strait of Georgia (Figure 2) followed the ten core sampling transects (1 – 6, 8 – 11); which are made up of 48 sampling stations and have been sampled consistently since 1990 (except 1995). These ten core transects have been used in juvenile herring recruitment prediction (Hay et. al. 2003). Originally, the sampling sites were chosen based on known historical herring spawning sites, and represent both nearshore and open water habitats (Haegele et. al. 2005). In 2013, sampling was conducted from September 11th to 25th (Table 1). All forty-eight core stations were sampled.

Fish Sampling

The 12 m, aluminum-hulled Fisheries Research Vessel *Walker Rock* was used for all fishing events. A 183 m long and 27 m deep purse seine net of knotless web, resulting in an area fished of ~2665 m^2, was used for all fishing events. The body of the net had 46 m of 22.2 mm mesh at the tow end followed by 91 m of 19.0 mm mesh, and the bunt end was 46 m of 9.5 mm mesh. The net fished to a depth of 10 m, and was able to retain fish greater than 20 mm in length. All sets were made after dusk when herring are feeding near the surface. All sets were made "blind" at the pre-determined sampling stations.

Five sets were completed per night, depending on location, and length of travel between transects and the marine weather forecast. For most sets, it was possible to land the entire catch for biological sampling. On occasion, it was not practical to land a large set in its entirety, so sub-sampling was necessary. When sub-sampling was required, a 40 kg tote was filled with randomly selected fish and retained for biological sampling. Several dipnet samples were taken from various parts of the net (catch) to make up the random sub-sample. The remainder of the set was released over the corkline, its size estimated as the number of totes released. The number of herring caught in each set was determined by dividing the total catch weight by the mean individual fish weights of the subsampled herring. The number of other species caught was determined in the same manner (Tables 3). All fish retained for sampling were bagged and preserved in a 3.7 % seawater formalin solution, with the exception of large predator species (e.g. adult salmon and flatfish). These fish were individually measured in the field. All retained fish were later sampled in the laboratory at the Pacific Biological Station. From each set, up to 100 herring are individually weighed and measured. Up to 25 individuals for all other species caught were identified, weighed and measured. If the set contained less than 100 herring, then all herring were weighed and measured. Consistent with standard practices, herring were measured to standard length, salmon to fork length and groundfish to total length; all to the nearest millimeter. All other fish species were measured to standard length.

Plankton Sampling

Twenty stepped oblique plankton tows were performed (Figure 3). The tows were always completed after dusk and immediately before the fishing events. A nearshore and offshore tow location was sampled on all transects. Dual 19 cm diameter bongo nets with 350 µm mesh were used for sampling, resulting in 'left' and 'right' bongo plankton samples (only left samples were processed). The bongos were lowered to 20 m depth (10 m in shallow areas) and raised by an electric winch at a rate of 1 m every 15 sec (or 1 m every 30 sec for shallow areas). The plankton tow is performed with the vessel doing a small circle at ~2 knots speed. The tow takes a total of 5 minutes to fully complete. A General Oceanics® 2030R model flowmeter was attached to the left bongo to determine the volume of seawater filtered. Volume filtered was calculated using the following equation (McCarter and Hay 2002):

$$\mathbf{V = (A \cdot F \cdot K) / 999{,}999}$$

where:

V = volume of water filtered through the plankton net (m^3)
A = area of net opening (0.02835 m^2)
F = number of revolutions recorded by the flow meter (m)
K = standard speed rotor constant for 7cm rotor (26,873)

Upon retrieval, the bongo nets were washed with a high pressure deck hose to rinse zooplankton into the codends, and the samples were preserved in 3.7 % seawater formalin.

In the laboratory, a volumetric splitter was used to reduce the sample size to where organisms could be conveniently counted and identified in a counting tray using a stereo microscope under 30X magnification. Sample splitting continued until a target size of roughly 300 organisms was reached (Thompson et al. 2003).

Zooplankton was identified to the lowest possible taxonomic level. Copepods were identified to species. Densities for all zooplankton species were determined and expressed as number of animals/ m^3.

RESULTS

Herring

Forty-eight stations were sampled from transects 1 – 6, 8 – 11. A total of 3241 herring were weighed and measured resulting in a length frequency distribution that was distinctly bimodal for age-0+ and age-1+ herring (Figure 4). Length designations for the juvenile herring age-classes are:

0+ = herring less than or equal to 107 mm standard length
1+ = herring between 108 mm and 151 mm standard length
2+ and older = herring greater than or equal to 152 mm standard length

Age-0+ herring occurred in 87.5 % of the stations (Table 3). Forty-two of the forty-eight stations contained age-0+ herring. The mean length and weight for age-0+ herring was 88 mm and 8.66 g respectively. A total of 21005 age-0+ were caught for a total weight of 168.85 kg (Table 4).

Age-1+ herring occurred in 54.2 % of the stations (Table 3). Twenty-six of the forty-eight stations sampled contained age-1+ herring. The mean length and weight for age-1+ herring was 127 mm and 27.10 g, respectively. A total of 7864 age-1+ herring were caught for a total weight of 212.18 kg (Table 4).

Age-2+ herring occurred in 14.6 % of the stations (Table 3). Seven of the forty-eight stations sampled contained age-2+ herring. The mean length and weight for age-2+ herring was 166 mm and 65.20 g, respectively. A total of 165 age-2+ herring were caught for a total weight of 8.71 kg (Table 4).

Length frequency histograms by transect location for all sampled herring are shown in Figure 5. All transects on the Vancouver island side were dominated by an age-0+ age-class with the mainland transects containing a mixture of age-0+ and age-1+ herring. As seen in previous surveys, Trincomali Channel (Transect 6) and Yellow Point (Transect 2) produced age-0+ herring smaller than the survey average. This is more than likely due to the variation in spawning times of herring above and below Dodds Narrows. A length-weight relationship for all sampled herring from the survey showed a positive correlation coefficient (r^2) of 0.9811 (Figure 6).

Plankton

There were 27 categories of organisms identified in 20 plankton samples (Tables 5, 6 and 7). An average of 13.453 m^3 of water was filtered per plankton tow. Calanoid copepod *Paracalanus parvus* and *Calanus sp.* were the only categories to occur in all samples. Calanoid copepod *Paracalanus parvus, Calanus sp.*, barnacles and larvaceans (*Oikopleura sp.*and *Fritillaria sp.*) occurred in >95% of the samples. More than 75% of all plankton biomass captured were barnacles, larvaceans (*Oikopleura sp.*and *Fritillaria sp.*), and calanoid copepods *Paracalanus parvus* and *Calanus sp.*

CONCLUSION

Forty-eight stations were sampled resulting in 18 different fish species recorded from purse seine sets. A total of 3241 herring were measured and weighed creating a bimodal histogram clearly representing age-0+ and age-1+ juvenile herring. Twenty plankton tows were performed resulting in calanoid copepod *Paracalanus* parvus, *Calanus sp.*, barnacles and larvaceans (*Oikopleura sp.*and *Fritillaria sp.*) being the predominant organisms in numbers and biomass.

ACKNOWLEDGMENTS

The 2013 Strait of Georgia juvenile herring survey was funded by the Department of Fisheries and Oceans. This survey could not have been possible without the hard work and good cheer of skipper Doug Henderson. Plankton samples were processed by Zotec services. Laboratory fish sampling help also provided by Sara Schroeder.

REFERENCES

Haegele, C.W. 1997. The occurrence, abundance and food of juvenile herring and salmon in the Strait of Georgia, British Columbia in 1990 to 1994. Can. Manuscr. Rep. Fish. Aquat. Sci. 2390: 124 p.

Haegele, C.W., Hay, D.E., Schweigert, J.F., Armstrong, R.W., Hrabok, C., Thompson, M., and Daniel, K. 2005. Juvenile herring surveys in Johnstone Strait and Georgia Straits – 1996 to 2003. Can. Data Rep. Fish. Aquat. Sci. 1171:xi + 243 p.

Hay, D.E., and McCarter, P.B. 1999. Age of sexual maturation and recruitment in Pacific herring. Can. Sci. Advis. Sec. Res. Doc. 99/175: 42 p.

Hay, D.E., Schweigert, J.F., Thompson, M., Haegele, C.W., and Midgley, P. 2003. Analyses of juvenile surveys for recruitment prediction in the Strait of Georgia. Can. Sci. Advis. Sec. Res. Doc. 2003/107: 28 p.

Hourston, A.S., and Haegele, C.W. 1980. Herring on Canada's Pacific coast. Can. Spec. Publ. Fish. Aquat. Sci. 48: 23 p.

Humphreys, R.D., and Hourston, A.S. 1978. British Columbia herring spawn deposition survey manual. Fish. Mar. Serv. Misc. Spec. Publ. 38: 40 p.

McCarter, P.B., and Hay, D.E. 2002. Eulachon embryonic egg and larval outdrift sampling manual for ocean and river surveys. Can. Tech. Rep. Fish. Aquat. Sci. 2451: 33 p.

Schweigert, J.F. Hay, D.E., Therriault, T.W., Thompson, M., and Haegele, C.W. 2009. Recruitment forecasting using indices of young-of-the-year (age-0^{+}) Pacific herring (*Clupea pallasi*) abundance in the Strait of Georgia, British Columbia, Canada. ICES Journal of Marine Science. 66:1681-1687.

Thompson, M., Hrabok, C., Hay, D.E., Schweigert, J., Haegele, C., and Armstrong, B. 2003. Juvenile herring surveys: methods and data base. Can. Manuscr. Rep. Fish. Aquat. Sci. 2651: 31 p.

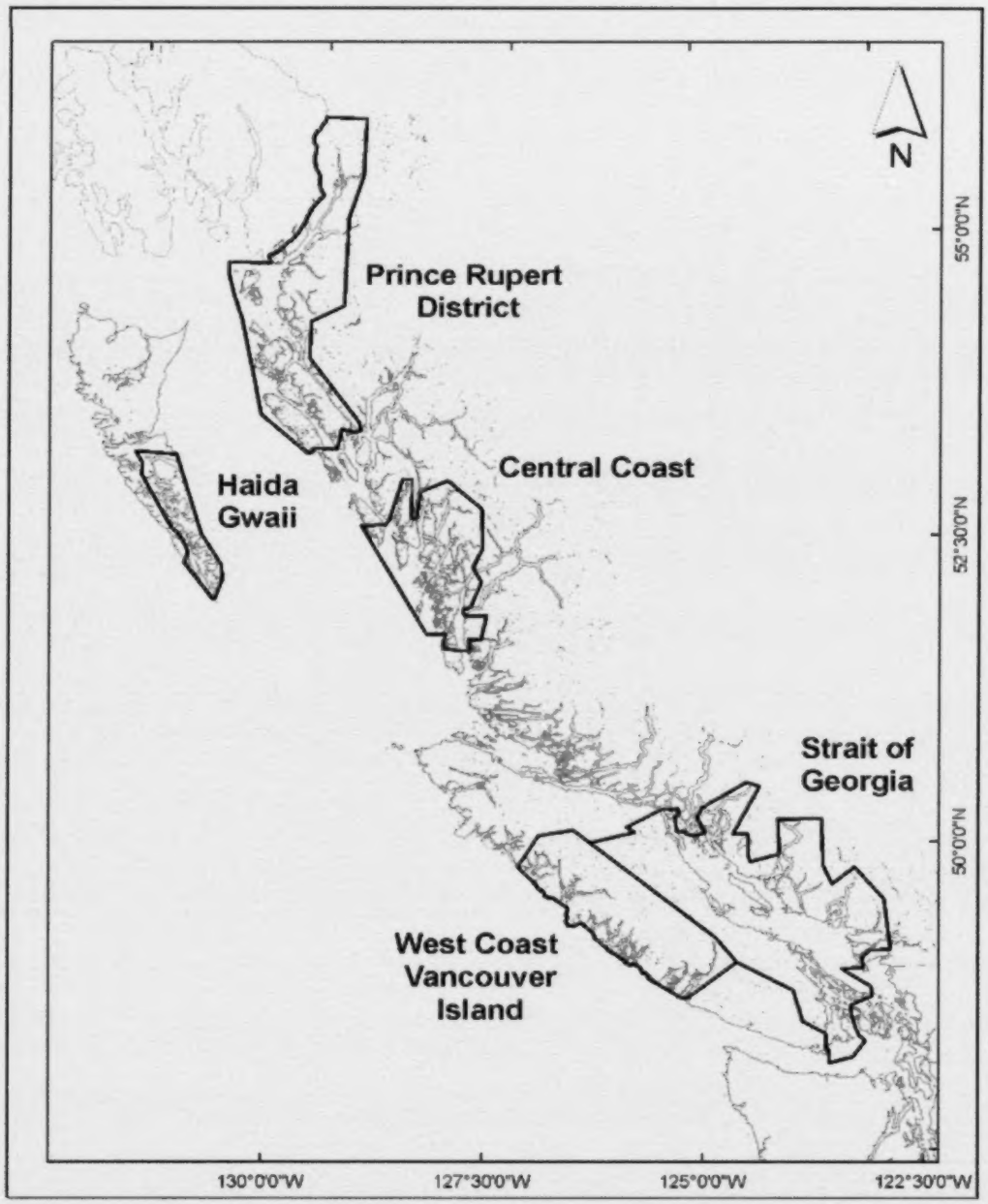


Figure 1. The five major British Columbia herring stock assessment areas.

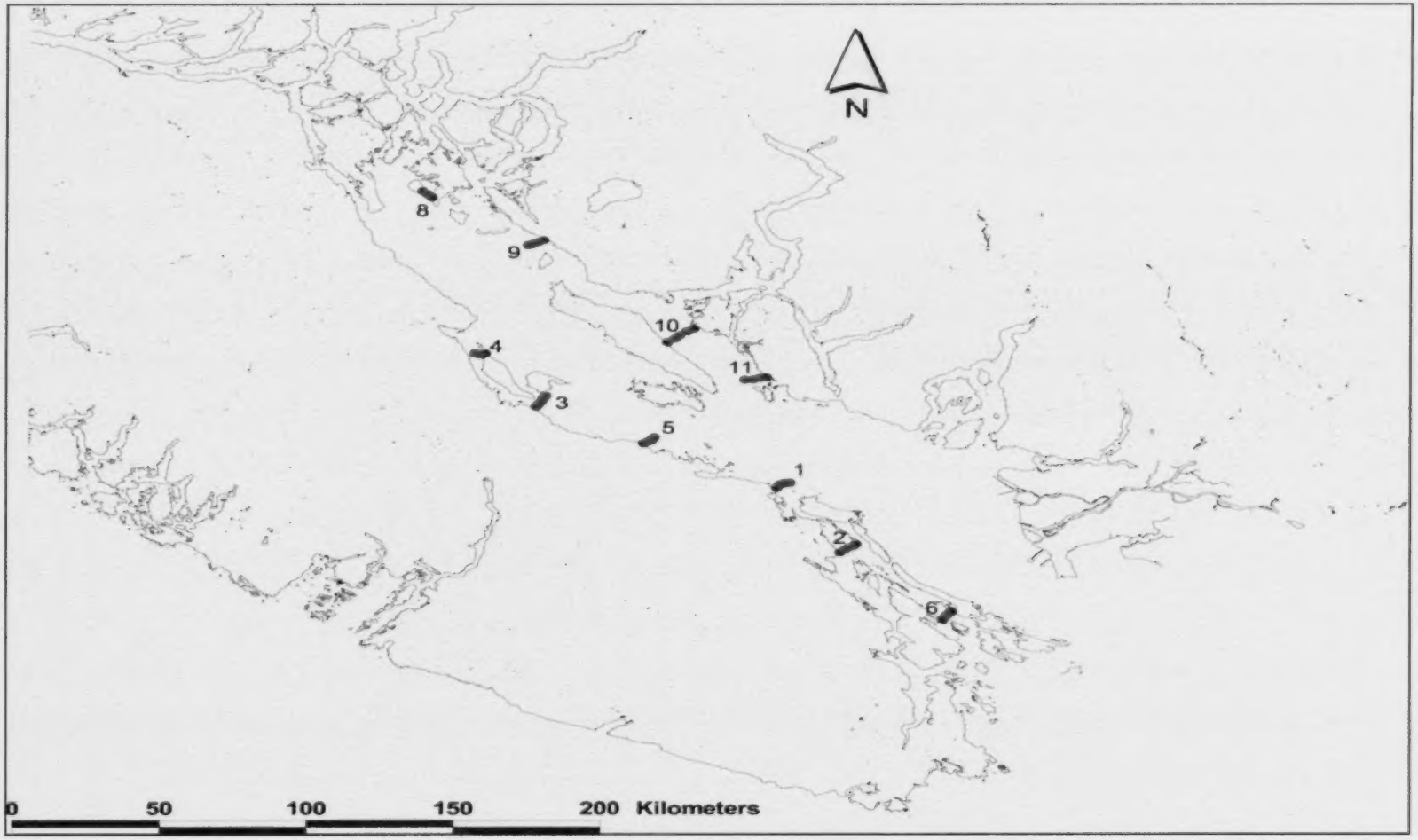


Figure 2. Purse seine set locations for the 2013 Strait of Georgia juvenile herring survey.

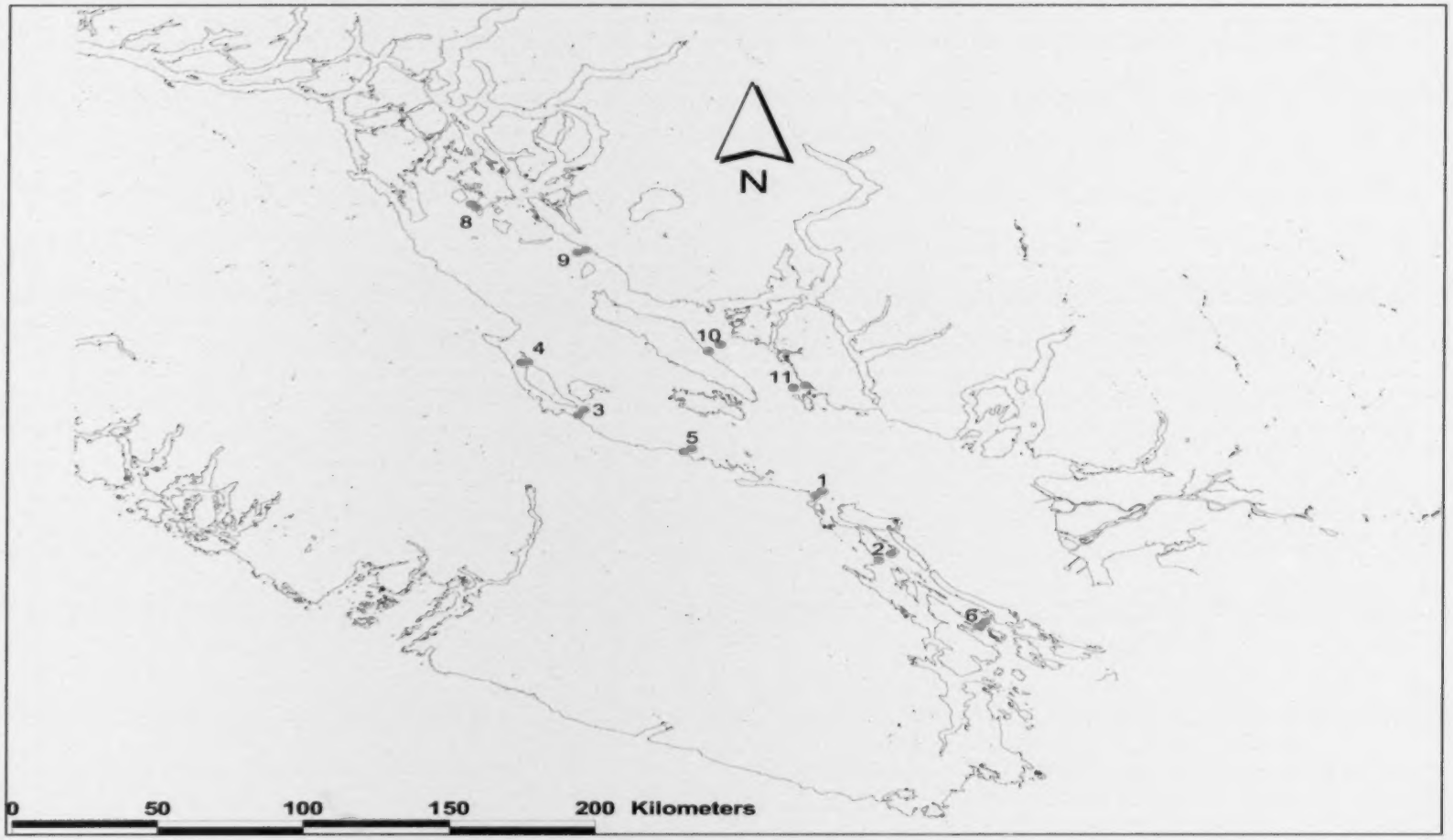


Figure 3. Plankton stations for 2013 Strait of Georgia juvenile herring survey.

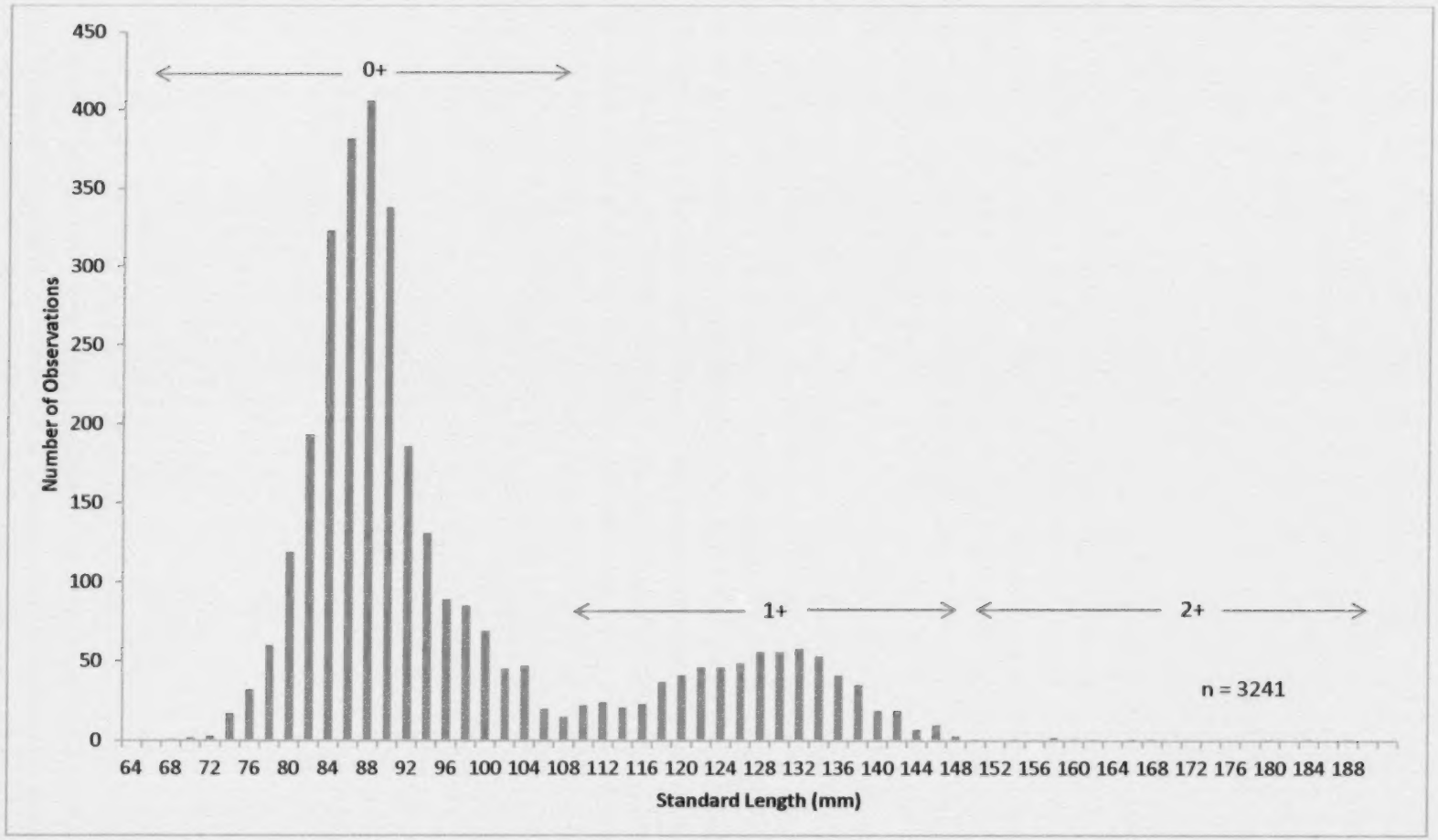
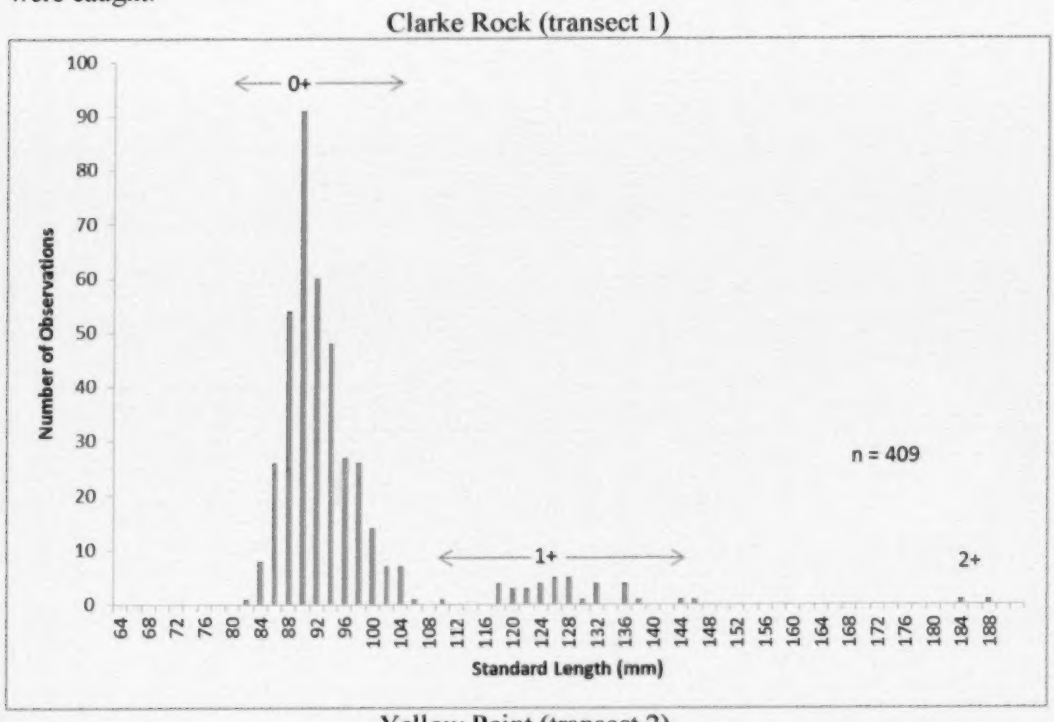
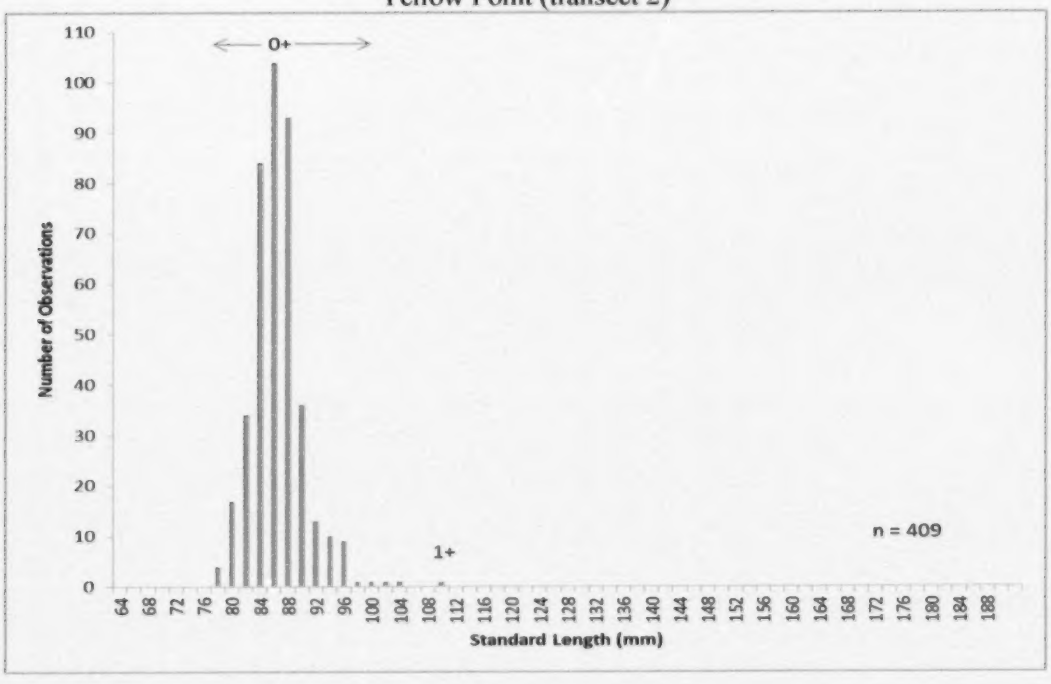
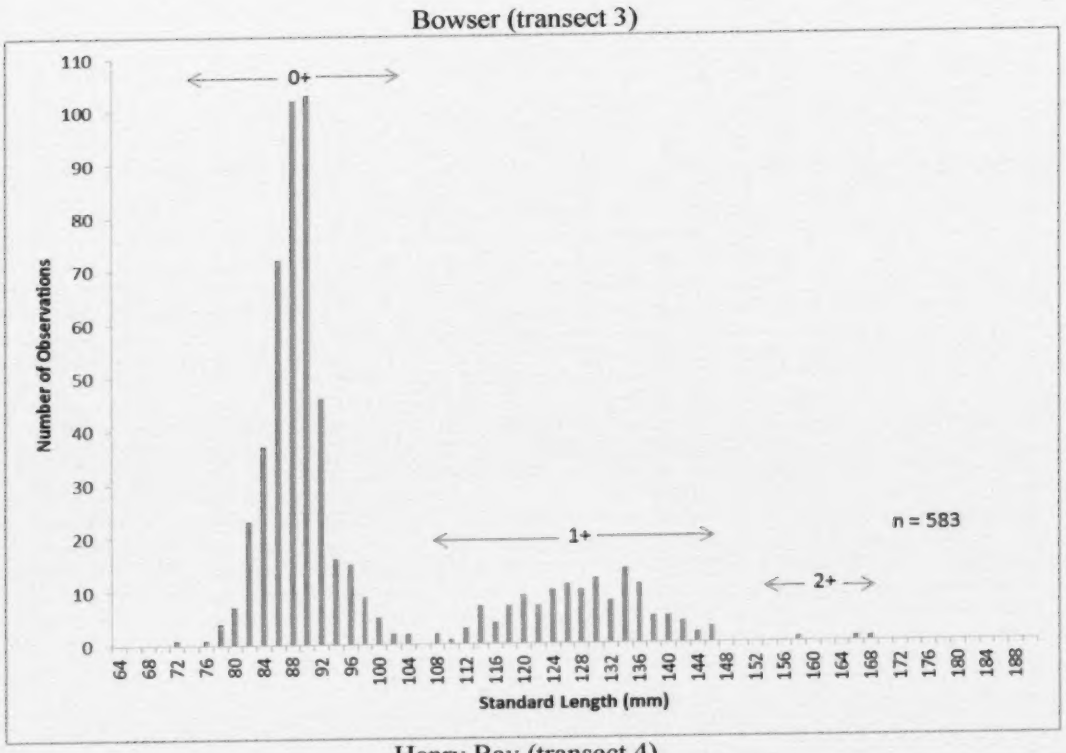


Figure 4. Length-frequency distribution for all herring sampled during the 2013 Strait of Georgia juvenile herring survey.

Figure 5. Length-frequency histograms of juvenile herring by transect location for the 2013 Strait of Georgia juvenile herring survey. Transect 9 is omitted because only 6 fish were caught.







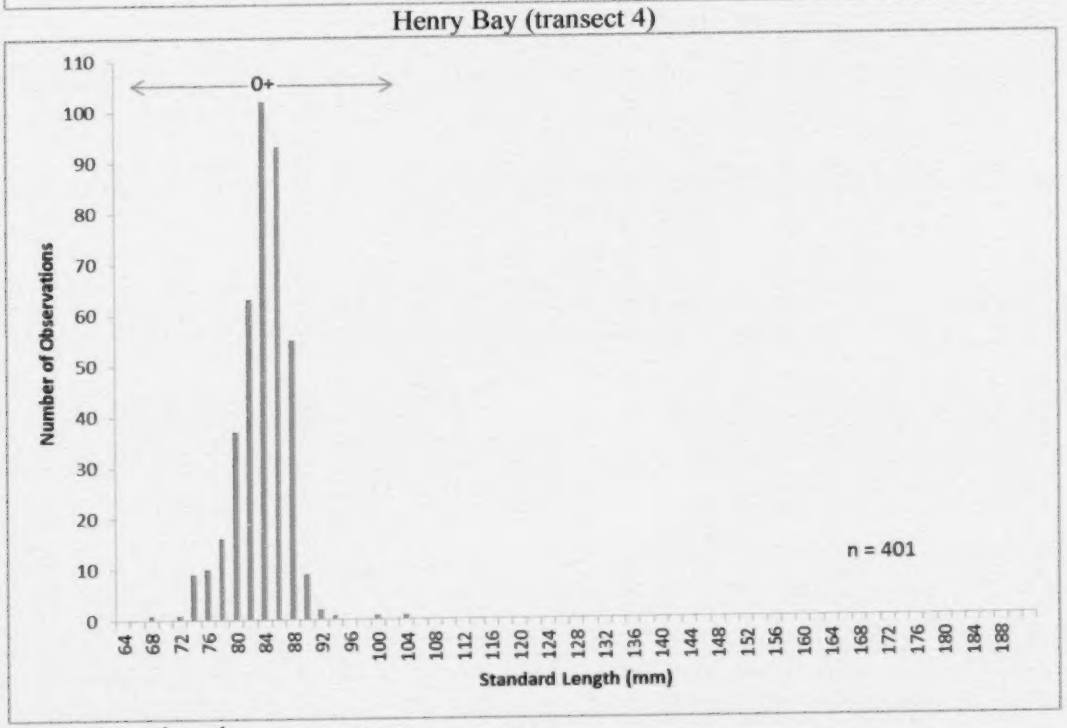
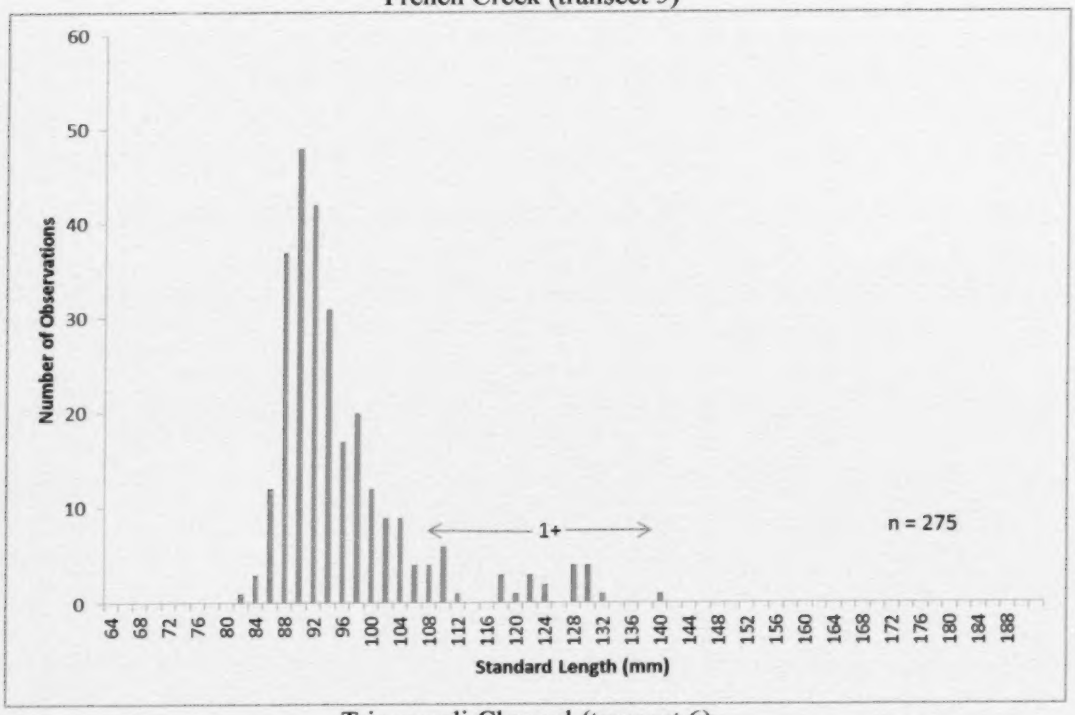
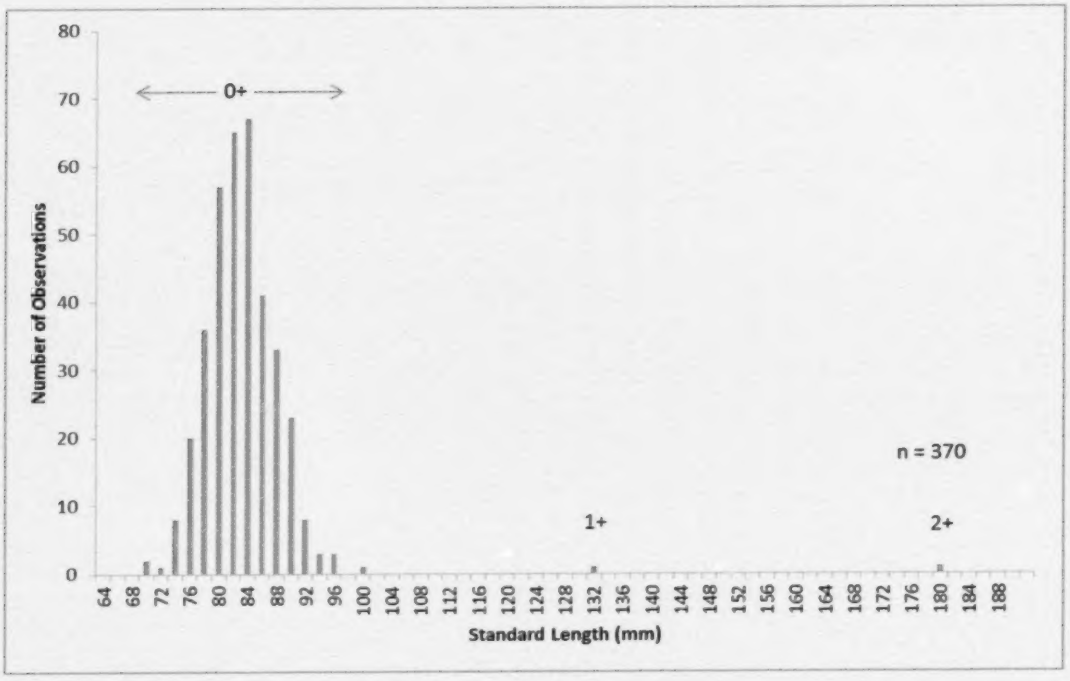


Figure 5 continued.

French Creek (transect 5)



Trincomali Channel (transect 6)



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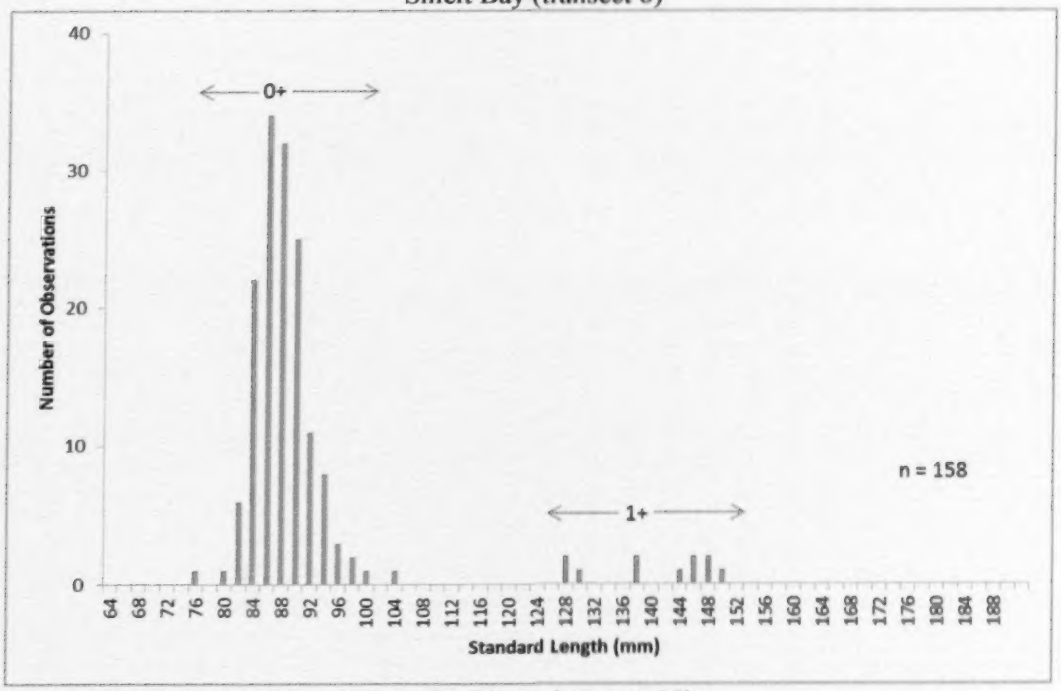
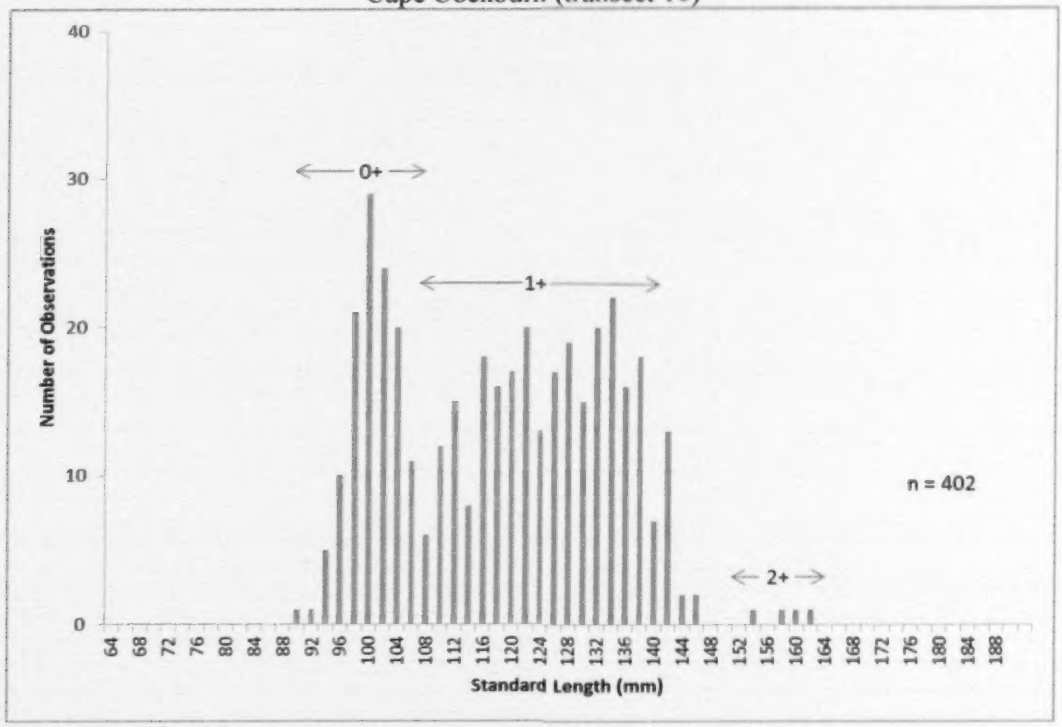
Smelt Bay (transect 8)



Cape Cockburn (transect 10)



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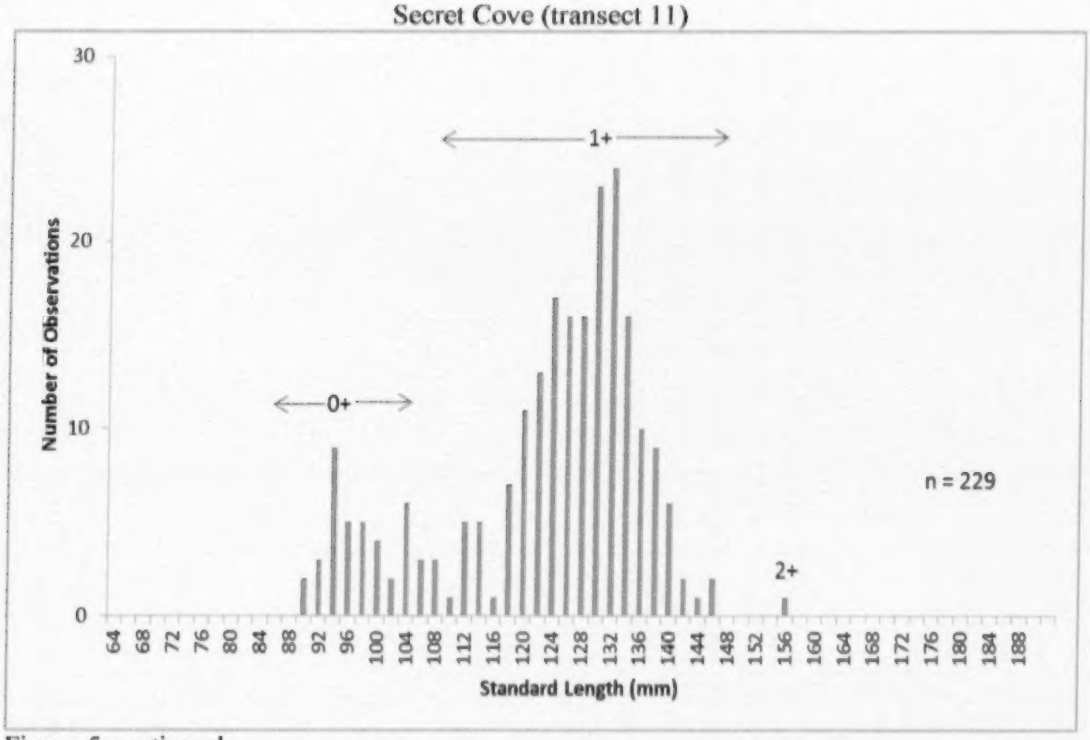

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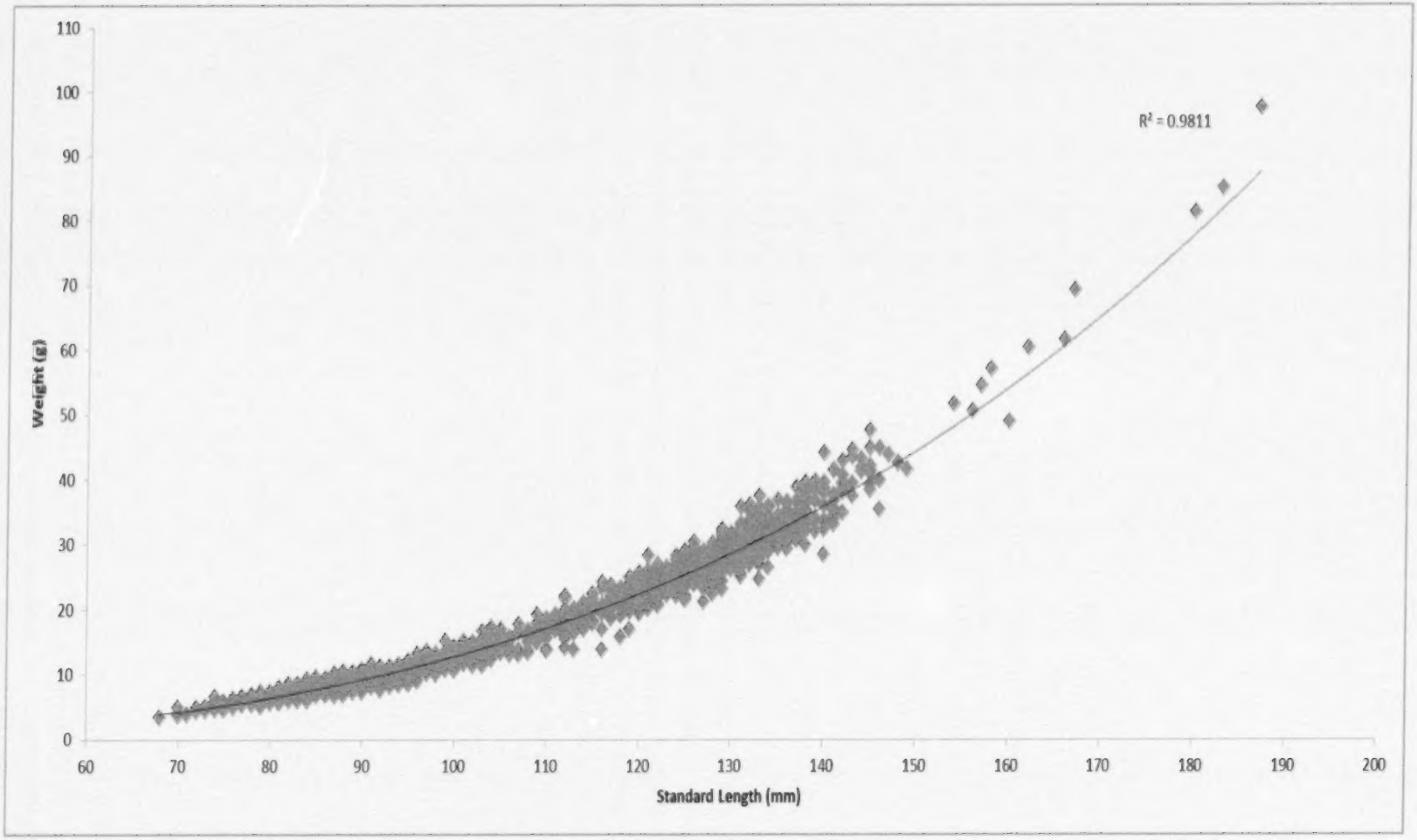

Figure 6. Length-weight relationship for all herring sampled during the 2013 Strait of Georgia juvenile herring survey.

Table 1. Summary of the purse seine set locations from the 2013 Strait of Georgia juvenile herring survey. DD = decimal degrees.

Year	Month	Day	Transect	Station	Seine Set Time	Location Name	DD Lat (N)	DD Long (W)
2013	9	11	6	1	2045	Trincomali Channel	48.855	123.430
2013	9	11	6	2	2110	Trincomali Channel	48.862	123.423
2013	9	11	6	3	2130	Trincomali Channel	48.867	123.417
2013	9	11	6	4	2150	Trincomali Channel	48.873	123.407
2013	9	11	6	5	2210	Trincomali Channel	48.877	123.407
2013	9	12	2	5	2045	Yellow Point	49.066	123.698
2013	9	12	2	4	2150	Yellow Point	49.060	123.708
2013	9	12	2	3	2130	Yellow Point	49.056	123.722
2013	9	12	2	2	2150	Yellow Point	49.050	123.733
2013	9	12	2	1	2210	Yellow Point	49.042	123.747
2013	9	13	1	1	2040	Clarke Rock	49.224	123.943
2013	9	13	1	2	2105	Clarke Rock	49.233	123.932
2013	9	13	1	3	2120	Clarke Rock	49.237	123.922
2013	9	13	1	4	2145	Clarke Rock	49.237	123.912
2013	9	13	1	5	2225	Clarke Rock	49.238	123.902
2013	9	16	5	5	2035	French Creek	49.366	124.317
2013	9	16	5	4	2055	French Creek	49.362	124.323
2013	9	16	5	3	2125	French Creek	49.358	124.327
2013	9	16	5	2	2145	French Creek	49.353	124.338
2013	9	16	5	1	2205	French Creek	49.348	124.350
2013	9	17	3	5	2050	Bowser	49.482	124.651
2013	9	17	3	4	2110	Bowser	49.476	124.657
2013	9	17	3	3	2135	Bowser	49.467	124.663
2013	9	17	3	2	2155	Bowser	49.459	124.672
2013	9	17	3	1	2210	Bowser	49.452	124.680
2013	9	18	4	1	2030	Henry Bay	49.593	124.875
2013	9	18	4	2	2055	Henry Bay	49.601	124.866
2013	9	18	4	3	2115	Henry Bay	49.598	124.856
2013	9	18	4	4	2135	Henry Bay	49.598	124.846
2013	9	18	4	5	2200	Henry Bay	49.602	124.836
2013	9	23	8	3	2030	Smelt Bay	50.054	125.030
2013	9	23	8	2	2055	Smelt Bay	50.046	125.016
2013	9	23	8	1	2120	Smelt Bay	50.036	125.000
2013	9	23	9	1	100	Atrevida Reef	49.916	124.659
2013	9	23	9	2	120	Atrevida Reef	49.912	124.673
2013	9	23	9	3	140	Atrevida Reef	49.909	124.684
2013	9	23	9	4	155	Atrevida Reef	49.906	124.694

Table 1 continued.

Year	Month	Day	Transect	Station	Seine Set Time	Location Name	DD Lat (N)	DD Long (W)
2013	9	23	9	5	220	Atrevida Reef	49.902	124.707
2013	9	24	10	1	2035	Cape Cockburn	49.670	124.198
2013	9	24	10	2	2105	Cape Cockburn	49.662	124.218
2013	9	24	10	3	2135	Cape Cockburn	49.651	124.242
2013	9	24	10	4	2205	Cape Cockburn	49.642	124.255
2013	9	24	10	5	2230	Cape Cockburn	49.632	124.278
2013	9	25	11	1	2030	Secret Cove	49.535	123.977
2013	9	25	11	2	2100	Secret Cove	49.532	123.995
2013	9	25	11	3	2125	Secret Cove	49.528	124.014
2013	9	25	11	4	2150	Secret Cove	49.527	124.040
2013	9	25	11	5	2215	Secret Cove	49.523	124.060

Table 2. Summary of the number and weight by species, transect, and station for 2013 Strait of Georgia juvenile herring survey.

Transect	Station	Location Name	Species	Number	Weight (Kg)*
1	1	Clarke Rock	**Pacific herring age-0+**	326	3.14
			Pacific herring age-1+	72	1.97
			Three-spine stickleback	66	0.21
			Sculpin	8	0.06
			Flatfish	6	0.07
			Midshipman	4	trace
			Squid	4	0.06
			Chum salmon	2	0.11
			Coho salmon	2	0.12
			Crab	2	0.14
1	2	Clarke Rock	**Pacific herring age-0+**	1302	12.79
			Squid	24	0.03
			Three-spine stickleback	6	0.01
1	3	Clarke Rock	**Pacific herring age-0+**	750	5.47
			Pacific herring age-1+	2	0.05
			Chum salmon	4	0.24
			Coho salmon	2	0.18
			Sculpin	2	0.01
1	4	Clarke Rock	**Pacific herring age-0+**	67	0.70
			Chinook salmon	5	0.58
			Chum salmon	4	0.38
			Coho salmon	4	0.67
			Hake, adult	1	0.38
			Pacific lamprey	1	0.02
			Walleye pollock, adult	1	0.43
1	5	Clarke Rock	**Pacific herring age-0+**	2	0.02
			Pacific herring age-2+	2	0.18
			Chum salmon	4	0.42
			Coho salmon	2	0.50
			Chinook salmon	1	0.14
			Hake, adult	1	0.35
			Walleye pollock, adult	1	0.62

* weights <0.01 Kg referred to as trace

Table 2 continued.

Transect	Station	Location Name	Species	Number	Weight (Kg)*
2	1	Yellow Point	**Pacific herring age-0+**	62	0.50
			Squid	16	0.03
			Midshipman	5	trace
			Shiner perch	2	0.01
			Pipefish	1	trace
2	2	Yellow Point	**Pacific herring age-0+**	187	1.56
			Squid	21	0.04
			Chinook salmon	2	0.06
			Coho salmon	1	0.05
			Northern anchovy	1	trace
			Pacific sand lance	1	trace
			Pipefish	1	trace
			Three-spine stickleback	1	trace
2	3	Yellow Point	**Pacific herring age-0+**	150	1.19
			Squid	60	0.04
			Three-spine stickleback	4	trace
2	4	Yellow Point	**Pacific herring age-0+**	277	2.25
			Pacific herring age-1+	1	0.02
			Squid	59	0.05
			Chinook salmon	3	0.11
			Chum salmon	2	0.09
			Northern anchovy	2	trace
			Three-spine stickleback	2	trace
2	5	Yellow Point	Chinook salmon	2	0.07
			Gunnel	1	0.01
			Midshipman	2	trace
			Northern anchovy	1	trace
			Pacific herring age-0+	71	0.54
			Pipefish	1	0.01
			Sculpin	1	0.03
			Shiner perch	1	trace
			Three-spine stickleback	5	0.01

Table 2 continued.

Transect	Station	Location Name	Species	Number	Weight (Kg)*
3	1	Bowser	**Pacific herring age-0+**	460	3.83
			Pacific herring age-1+	4	0.08
			Shiner perch	22	0.25
			Chinook salmon	4	0.17
			Flatfish	2	0.22
			Pink salmon	2	0.13
			Sculpin	2	0.04
3	2	Bowser	**Pacific herring age-0+**	45	0.38
			Pacific herring age-1+	10	0.33
			Pacific herring age-2+	1	0.07
			Squid	10	0.01
			Chinook salmon	2	0.21
			Coho salmon	1	0.12
3	3	Bowser	**Pacific herring age-0+**	1065	9.52
			Pacific herring age-1+	235	6.52
			Pacific herring age-2+	10	0.59
3	4	Bowser	**Pacific herring age-0+**	1267	11.10
			Pacific herring age-1+	392	10.69
3	5	Bowser	**Pacific herring age-0+**	324	2.61
			Pacific herring age-1+	40	1.13
			Squid	6	0.01
			Flatfish	4	0.07
4	1	Henry Bay	***NO CATCH***		
4	2	Henry Bay	**Pacific herring age-0+**	3179	24.55
			Walleye pollock, juvenile	34	0.24
4	3	Henry Bay	**Pacific herring age-0+**	3258	24.84
			Three-spine stickleback	72	0.03
			Squid	56	0.22
4	4	Henry Bay	**Pacific herring age-0+**	356	2.85
			Three-spine stickleback	10	trace
			Midshipman	8	0.01
			Chinook salmon	2	0.12

Table 2 continued.

Transect	Station	Location Name	Species	Number	Weight (Kg)*
4	5	Henry Bay	**Pacific herring age-0+**	200	1.48
			Midshipman	4	0.01
			Three-spine stickleback	4	trace
			Squid	2	trace
5	1	French Creek	**Pacific herring age-0+**	59	0.57
			Pacific herring age-1+	2	0.03
			Shiner perch	36	0.23
			Flatfish	5	0.13
			Midshipman	2	trace
			Sculpin	2	0.02
			Chinook salmon	1	0.04
			Squid	1	0.02
5	2	French Creek	**Pacific herring age-0+**	54	0.55
			Pacific herring age-1+	9	0.21
			Squid	5	trace
			Chinook salmon	2	0.15
			Three-spine stickleback	1	trace
5	3	French Creek	**Pacific herring age-0+**	115	1.11
			Pacific herring age-1+	11	0.26
			Chinook salmon	1	0.06
			Coho salmon	1	0.27
			Northern anchovy	1	0.02
			Squid	1	0.02
5	4	French Creek	**Pacific herring age-0+**	19	0.20
			Pacific herring age-1+	6	0.10
			Chum salmon	3	0.31
			Coho salmon	2	0.33
			Chinook salmon	1	0.08
5	5	French Creek	Coho salmon	5	0.98

Table 2 continued.

Transect	Station	Location Name	Species	Number	Weight (Kg)*
6	1	Trincomali Channel	**Pacific herring age-0+**	163	1.12
			Pacific herring age-2+	1	0.08
			Squid	10	0.01
			Three-spine stickleback	1	trace
			Walleye pollock, juvenile	1	0.01
6	2	Trincomali Channel	**Pacific herring age-0+**	40	0.27
			Chum salmon	3	0.15
			Northern anchovy	1	trace
			Pacific sand lance	1	trace
6	3	Trincomali Channel	**Pacific herring age-0+**	44	0.30
			Pacific herring age-1+	1	0.03
			Chum salmon	7	0.48
			Pacific sand lance	1	trace
			Walleye pollock, juvenile	1	trace
6	4	Trincomali Channel	**Pacific herring age-0+**	84	0.60
			Chum salmon	12	0.68
6	5	Trincomali Channel	**Pacific herring age-0+**	6162	44.90
8	1	Smelt Bay	**Pacific herring age-0+**	21	0.21
			Pacific herring age-1+	11	0.40
			Chum salmon	5	0.39
			Pipefish	2	trace
			Midshipman	1	trace
			Pink salmon	1	0.03
			Squid	1	trace
8	2	Smelt Bay	**Pacific herring age-0+**	26	0.24
			Three-spine stickleback	15	0.02
			Chum salmon	6	0.59
			Crab	1	trace
			Pipefish	1	trace
			Squid	1	0.01

Table 2 continued.

Transect	Station	Location Name	Species	Number	Weight (Kg)*
8	3	Smelt Bay	**Pacific herring age-0+**	338	2.76
			Three-spine stickleback	17	0.01
			Pipefish	3	trace
			Pink salmon	1	0.06
9	1	Atrevida Reef	Northern anchovy	299	0.61
			Three-spine stickleback	37	0.03
			Pipefish	2	trace
			Chinook salmon	1	0.03
9	2	Atrevida Reef	Chum salmon	1	0.05
9	3	Atrevida Reef	**Pacific herring age-0+**	2	0.03
			Chum salmon	5	0.40
9	4	Atrevida Reef	**Pacific herring age-1+**	1	0.02
			Chum salmon	5	0.43
9	5	Atrevida Reef	**Pacific herring age-0+**	1	0.01
			Pacific herring age-1+	2	0.08
			Chum salmon	4	0.34
10	1	Cape Cockburn	**Pacific herring age-0+**	370	4.69
			Pacific herring age-1+	6697	180.49
			Pacific herring age-2+	148	7.64
10	2	Cape Cockburn	**Pacific herring age-0+**	23	0.30
			Pacific herring age-1+	82	2.26
			Pacific herring age-2+	2	0.11
			Hake, juvenile	4	0.01
			Chinook salmon	1	0.04
			Chum salmon	1	0.09
			Hake, adult	1	0.06
			Squid	1	0.10

Table 2 continued.

Transect	Station	Location Name	Species	Number	Weight (Kg)*
10	3	Cape Cockburn	**Pacific herring age-0+**	58	0.73
			Pacific herring age-1+	62	1.61
			Chinook salmon	1	0.05
			Chum salmon	1	0.09
			Midshipman	1	trace
			Squid	1	0.02
10	4	Cape Cockburn	**Pacific herring age-0+**	28	0.36
			Pacific herring age-1+	21	0.58
			Chinook salmon	4	0.17
			Chum salmon	1	0.10
10	5	Cape Cockburn	**Pacific herring age-0+**	10	0.12
			Pacific herring age-1+	16	0.40
			Chum salmon	10	0.79
			Chinook salmon	7	0.34
			Midshipman	1	trace
11	1	Secret Cove	**Pacific herring age-0+**	14	0.15
			Pacific herring age-1+	14	0.36
			Three-spine stickleback	290	0.36
			Chinook salmon	27	1.01
			Chum salmon	20	1.40
			Midshipman	9	0.01
			Hake, juvenile	3	0.11
11	2	Secret Cove	**Pacific herring age-0+**	17	0.20
			Pacific herring age-1+	7	0.18
			Pacific herring age-2+	1	0.03
			Chum salmon	8	0.52
			Midshipman	6	trace
			Chinook salmon	5	0.18
			Three-spine stickleback	5	trace
			Hake, juvenile	4	0.16
			Northern anchovy	2	0.01
			Sculpin	1	0.02

Table 2 continued.

Transect	Station	Location Name	Species	Number	Weight (Kg)*
11	3	Secret Cove	**Pacific herring age-0+**	1	0.01
			Pacific herring age-1+	102	2.76
			Chinook salmon	5	0.20
			Chum salmon	5	0.45
			Hake, juvenile	2	0.04
			Coho salmon	1	0.15
			Pipefish	1	trace
11	4	Secret Cove	**Pacific herring age-0+**	8	0.12
			Pacific herring age-1+	63	1.70
			Chum salmon	5	0.45
			Chinook salmon	1	0.04
11	5	Secret Cove	**Pacific herring age-1+**	1	0.04
			Chinook salmon	1	0.04

Table 3. Percent occurrence by species in purse seine sets for the Strait of Georgia juvenile herring survey in 2013.

		% Occurrence
Common Name	**Scientific Name**	**2013**
Pacific herring age-0+	*Clupea pallasi* in year of birth	87.5
Pacific herring age-1+	*Clupea pallasi* in first year	54.2
Pacific herring age-2+	*Clupea pallasi* in second or more years	14.6
Adult hake	*Merluccius productus*	6.3
Adult walleye pollock	*Theragra chalcogramma*	4.2
Bay pipefish	*Syngnathus griseolineatus*	16.7
Chinook salmon	*Oncorhyncus tshawytscha*	45.8
Chum salmon	*Oncorhyncus keta*	47.9
Coho salmon	*Oncorhyncus kisutch*	20.8
Crab	*Metacarcinus magister*	4.2
Flatfish	*Parophyrus vetulus, Lepidopsetta bilineata, Platichthys stellatus, Citharichthys stigmaens*	8.3
Gunnel	*Apodichthys flavidus, Pholis laeta*	2.1
Juvenile hake	*Merluccius productus*	8.3
Juvenile walleye pollock	*Theragra chalcogramma*	6.3
NO CATCH		2.1
Northern anchovy	*Engraulis mordax mordax*	14.6
Pacific sand lance	*Ammodytes hexapterus*	6.3
Pink salmon	*Oncorhyncus gorbuscha*	6.3
Plainfin midshipman	*Porichthys notatus*	22.9
Sculpin	*Leptocottus armatus*	12.5
Shiner perch	*Cymatogaster aggregata*	8.3
Squid	*Loligo opalescens, Gonatus fabricii*	37.5
Three-spine stickleback	*Gasterosteus aculeatus*	33.3

* Jellyfish occurrence is not included due to the large quantities usually encountered and the inability to correctly quantify.

Table 4. Summary of the number of herring sampled, range of length, mean length, range of weight, mean weight, and standard deviations for three age classes sampled during the 2013 Strait of Georgia juvenile herring survey. Total catch in numbers (N) and weight (Wt) of all herring are shown for each transect.

Age-0+ Herring			Length (mm)			Weight (g)				
Location Name	Transect	Number Sampled	Range	Mean	SD	Range	Mean	SD	N	Wt (Kg)
Clarke Rock	1	370	82-105	92	4.37	6.87-17.29	9.88	1.54	2447	22.11
Yellow Point	2	408	78-103	86	3.64	5.88-13.37	8.06	1.06	747	6.05
Bowser	3	445	72-103	88	4.22	4.97-14.55	8.54	1.26	3161	27.44
Henry Bay	4	401	68-104	83	3.76	3.50-14.93	7.56	1.00	6993	53.71
French Creek	5	247	82-107	93	5.15	6.95-16.49	9.81	1.80	247	2.42
Trincomali	6	368	70-99	83	4.56	3.69-11.88	6.96	1.14	6493	47.19
Smelt Bay	8	147	75-103	87	3.90	5.06-13.73	8.66	1.30	385	3.21
Atrevida Reef	9	3	98-105	101	3.79	12.21-14.26	12.96	1.13	3	0.04
Cape Cockburn	10	124	90-107	100	3.38	8.51-17.79	12.65	1.71	489	6.19
Secret Cove	11	40	89-107	98	4.98	9.01-16.52	12.04	2.22	40	0.48
All locations		2553	68-107	88	4.18	3.50-17.79	8.66	1.42	21005	168.85

Table 4 continued.

Age-1+ Herring			Length (mm)			Weight (g)				
Location Name	Transect	Number Sampled	Range	Mean	SD	Range	Mean	SD	N	Wt (Kg)
Clarke Rock	1	37	109-145	127	7.69	17.05-47.49	27.34	6.11	74	2.02
Yellow Point	2	1	-	110	-	-	17.53	-	1	0.02
Bowser	3	135	108-146	127	8.83	15.72-44.85	28.14	6.49	681	18.74
Henry Bay	4	-	-	-	-	-	-	-	-	-
French Creek	5	28	108-140	120	8.97	13.38-29.16	21.29	4.83	28	0.60
Trincomali	6	1	-	131	-	-	27.43	-	1	0.03
Smelt Bay	8	11	127-149	140	8.50	26.11-43.70	36.26	6.42	11	0.40
Atrevida Reef	9	3	113-148	131	17.56	16.44-42.61	30.82	13.27	3	0.09
Cape Cockburn	10	274	108-146	126	9.53	13.86-44.74	26.85	6.73	6878	185.34
Secret Cove	11	187	108-146	128	7.51	15.55-44.49	27.01	4.91	187	5.05
All locations		677	108-149	127	9.80	13.38-47.49	27.10	6.97	7864	212.28

Table 4 continued.

Age-2+ Herring			Length (mm)			Weight (g)				
Location Name	Transect	Number Sampled	Range	Mean	SD	Range	Mean	SD	N	Wt (Kg)
Clarke Rock	1	2	183-187	185	2.83	84.98-97.52	91.25	8.87	2	0.18
Yellow Point	2	-	-	-	-	-	-	-	-	-
Bowser	3	3	158-167	164	4.93	57.03-69.12	62.58	6.11	11	0.66
Henry Bay	4	-	-	-	-	-	-	-	-	-
French Creek	5	-	-	-	-	-	-	-	-	-
Trincomali	6	1	-	180			81.23		1	0.08
Smelt Bay	8	-	-	-	-	-	-	-	-	-
Atrevida Reef	9	-	-	-	-	-	-	-	-	-
Cape Cockburn	10	4	154-162	158	3.50	48.84-60.37	53.82	4.93	150	7.76
Secret Cove	11	1	-	156	-	-	50.50	-	1	0.03
All locations		11	154-187	166	3.75	48.84-97.52	65.20	6.64	165	8.71

Table 5. Organisms by phylum, and with abbreviations, observed in zooplankton samples collected during the 2013 Strait of Georgia juvenile herring survey.

Coelenterata	
COEL	Medusae - *Aequorea victoria*
SIPH	Siphonophores
Ctenophora	
CTEN	Ctenophores
Annelida	
POLY	Polychaetes
Mollusca	
GAST	Prosobranch gastropods
PELE	Pelecypods
Arthropoda	
AMPH	Amphipods
BARN	Barnacle, unknown stage
CLAD	Cladocerans; *Podon sp.* and *Evadne sp.*
CNAU	Unidentified copepod nauplii
COPE	Copepods (see Table 9 for list of species)
CRAM	Crab megalopea, including porcillinadea
CRAZ	Crab zoea, including porcillinadea
EUPA	Adult euphausiids; mainly *Euphausia pacifica*
EUPL	Larval euphausiids; mainly *Euphausia pacifica*
INSE	Insects
MYSI	Mysids
OSTR	Ostracods
SHRI	Shrimp zoea
TLON	*Thysanoessa longipes*
TSPI	*Thysanoessa spinifera*
Echinoderm	
ECHI	Echinoderms
Ectoprocta	
ECTO	Ectoprocts; mainly *Membranipora sp.* larvae
Chaetognatha	
CHAE	Chaetognaths; mainly *Sagitta sp.*
Chordata	
FISHL	Fish larvae
LARV	Larvaceans; mainly *Oikopleura sp.* and some *Fritillaria sp.*
Miscellaneous	
EGGS	Unidentified eggs; either euphausiid or teleost

Table 6. Abbreviations for calanoid and cyclopoid copepods identified in the 2013 zooplankton samples from the Strait of Georgia juvenile herring survey.

Calanoid copepods	
ACLA	*Acartia clausi*
AETI	*Aetidius sp.*
ALON	*Acartia longiremis*
CABD	*Centropages abdominates*
CALA	*Calanus sp.*
CCOL	*Canadacia columbiae*
CMAR	*Calanus marshallae*
CPAC	*Calanus pacificus*
EBUN	*Eucalanus bungii*
EELO	*Eucalanus elongatus*
ELON	*Epilabidocera longipedata*
MPAC	*Metridia pacifica*
OBOR	*Oncaea borealis*
PPAR	*Paracalanus parvus*
PSEU	*Pseudocalanus sp.*
TDIS	*Tortanus discaudatus*

Cyclopoid copepods	
CANG	*Corycaeus anglicus*
OATL	*Oithona atlantica*
OSIM	*Oithona similis*

Table 7. Volume of water filtered and number of zooplankton per m^3 of water in samples collected during the 2013 Strait of Georgia juvenile herring survey. Species codes as shown in Tables 5 and 6.

Location	Tran	Stn	Volume (m^3)	ACLA	ALON	AMPH	BARN	CABD	CALA	CANG	CCOL	CHAE
Clarke Rock	1	1	12.761	-	1.9	-	12.5	-	0.6	4.4	-	-
		3	15.172	-	-	1.1	22.3	-	3.7	3.7	-	-
Yellow Point	2	1	8.527	-	-	-	270.3	-	41.3	78.8	-	-
		4	6.425	-	-	10.0	239.4	-	85.4	62.3	-	0.3
Bowser	3	1	11.361	-	2.1	0.1	597.3	-	9.3	-	-	-
		3	16.292	-	-	3.6	26.6	1.0	18.8	2.9	-	0.1
Henry Bay	4	1	7.110	-	2.8	5.3	275.1	0.6	8.2	5.1	-	-
		3	8.837	-	-	0.2	3157.6	-	29.0	36.2	-	-
French Creek	5	1	14.957	6.7	0.5	1.1	84.8	-	0.4	1.1	-	-
		3	16.995	-	7.1	4.9	2.5	-	10.4	0.5	-	-
Trincomali	6	1	12.998	-	-	9.9	202.0	-	10.3	65.2	-	-
		3	16.358	-	7.8	7.9	172.2	-	93.1	74.3	-	0.4
Smelt Bay	8	1	14.569	-	4.4	11.0	15.5	-	130.0	26.4	-	-
		2	14.505	-	-	13.2	101.5	-	324.3	8.8	-	-
Atrevida Reef	9	1	17.077	-	1.9	7.5	3.8	-	109.2	22.5	-	0.1
		3	16.803	-	1.9	1.7	4.8	-	142.6	30.5	-	-
Cape Cockburn	10	1	16.252	-	-	8.9	6.0	-	8.6	-	-	-
		3	14.821	-	0.5	8.1	-	-	20.6	7.6	-	0.5
Secret Cove	11	1	13.142	-	-	2.5	57.3	-	10.7	37.7	-	-
		3	14.101	-	-	8.2	20.4	-	114.4	22.7	0.1	-
Totals			13.453	6.7	30.9	105.1	5271.9	1.5	1171.0	490.6	0.1	1.3

Table 7 continued.

Location	Tran	Stn	CLAD	CMAR	CNAU	COEL	CPAC	CRAM	CRAZ	CTEN	EBUN	ECHI	ECTO	EELO	EGGS
Clarke Rock	1	1	22.6	-	-	27.6	-	-	2.6	2.5	-	-	2.5	-	5.0
		3	1.1	-	-	8.6	-	-	-	-	-	-	-	-	1.1
Yellow Point	2	1	15.0	-	7.5	24.0	-	0.1	0.7	30.8	-	-	15.0	-	-
		4	-	-	-	13.1	1.2	-	0.3	30.5	-	-	-	-	-
Bowser	3	1	185.9	-	-	-	-	-	5.6	-	-	-	-	-	-
		3	6.9	-	-	0.6	-	0.1	0.1	0.5	-	-	-	-	2.0
Henry Bay	4	1	157.5	-	9.0	7.3	0.6	18.0	43.0	-	-	-	4.5	-	-
		3	144.8	-	-	2.1	-	0.5	0.9	-	-	-	-	-	-
French Creek	5	1	54.6	-	-	0.3	-	-	-	-	-	-	-	-	-
		3	2.5	-	-	0.1	2.1	-	0.1	-	-	-	-	-	-
Trincomali	6	1	14.8	-	-	6.8	0.4	-	0.5	-	-	-	0.1	-	-
		3	15.6	-	0.1	17.3	0.2	0.1	0.6	4.0	-	-	-	-	-
Smelt Bay	8	1	2.2	-	4.4	44.3	-	0.1	4.4	33.1	-	-	-	-	-
		2	52.9	-	22.1	2.1	2.1	0.8	1.7	4.6	-	-	-	-	-
Atrevida Reef	9	1	-	-	-	1.1	0.3	-	-	0.7	-	31.9	-	-	-
		3	-	-	-	1.4	-	-	0.1	1.0	-	-	-	0.2	0.5
Cape Cockburn	10	1	-	-	-	7.9	0.1	-	-	0.2	-	-	-	-	-
		3	-	0.5	-	-	14.0	-	-	-	-	-	-	1.6	-
Secret Cove	11	1	4.9	-	-	4.0	-	0.2	-	1.4	-	-	1.2	-	-
		3	4.5	-	-	9.3	1.3	-	-	1.1	0.1	-	-	0.1	-
Totals			685.8	0.5	43.1	178.0	22.2	19.9	60.6	110.4	0.1	31.9	23.3	1.9	8.5

Table 7 continued.

Location	Tran	Stn	ELON	EUPA	EUPL	FISHL	GAST	INSE	LARV	MPAC	MYSI	OATL	OBOR
Clarke Rock	1	1	-	-	-	-	2.5	2.5	368.6	-	-	-	-
		3	-	-	1.1	-	3.2	-	42.2	-	-	1.1	-
Yellow Point	2	1	0.1	-	-	-	-	-	1035.7	-	-	-	-
		4	-	-	10.0	-	10.0	-	717.1	-	-	-	-
Bowser	3	1	-	-	5.6	-	5.6	-	214.1	-	-	11.3	-
		3	-	-	2.0	-	2.5	0.1	12.3	1.0	-	2.0	-
Henry Bay	4	1	-	-	-	-	4.5	-	-	-	-	1.7	-
		3	-	-	-	-	-	-	202.8	-	-	-	-
French Creek	5	1	-	-	-	-	3.2	-	3.2	-	-	-	-
		3	-	0.1	0.1	-	1.3	-	0.4	0.7	-	12.2	0.5
Trincomali	6	1	0.1	-	-	-	9.8	-	123.1	-	-	-	-
		3	-	-	-	-	19.6	0.1	168.2	-	-	-	-
Smelt Bay	8	1	-	-	6.6	-	35.1	-	79.1	-	-	-	-
		2	-	0.1	22.1	-	101.5	-	159.0	-	-	-	-
Atrevida Reef	9	1	-	-	1.9	-	7.5	-	15.0	0.2	0.1	-	-
		3	-	1.5	2.9	-	7.3	-	28.6	5.7	-	-	-
Cape Cockburn	10	1	-	-	-	-	1.0	-	7.9	-	1.0	-	-
		3	-	12.4	1.1	-	1.1	-	0.5	2.4	-	0.5	-
Secret Cove	11	1	-	-	-	-	14.6	-	69.4	-	0.3	-	-
		3	-	-	-	0.2	1.1	-	74.9	0.3	-	1.1	-
Totals			0.2	14.1	53.2	0.2	231.4	2.6	3322.0	10.3	1.3	29.9	0.5

Table 7 continued.

Location	Tran	Stn	OSIM	OSTR	PELE	POLY	PPAR	PSEU	SHRI	SIPH	TDIS	TLON	TSPI
Clarke Rock	1	1	1.3	-	-	-	36.4	-	-	-	-	-	-
		3	5.3	-	-	-	23.5	11.3	-	0.1	-	-	-
Yellow Point	2	1	-	-	7.5	-	213.9	-	0.1	33.1	-	-	-
		4	-	-	-	-	96.3	-	10.9	94.0	-	-	-
Bowser	3	1	24.6	-	5.6	-	34.9	5.8	-	-	-	-	-
		3	11.8	-	0.5	-	13.4	10.0	0.5	2.1	-	0.1	-
Henry Bay	4	1	5.6	-	-	-	22.1	1.7	0.1	6.2	18.8	-	-
		3	38.0	-	-	29.0	87.6	7.6	1.6	93.8	17.0	-	-
French Creek	5	1	7.2	-	-	1.1	5.8	0.4	-	-	-	-	-
		3	3.8	-	0.4	-	3.8	21.1	1.1	-	0.5	-	0.1
Trincomali	6	1	16.0	0.6	19.7	19.9	60.9	33.0	15.1	20.2	-	-	-
		3	3.9	-	23.5	19.6	87.7	50.1	0.1	3.9	0.01	-	-
Smelt Bay	8	1	39.5	-	-	-	195.7	30.1	13.7	107.5	-	-	-
		2	30.9	-	17.6	-	161.0	8.8	18.6	87.3	-	0.1	-
Atrevida Reef	9	1	67.5	-	5.6	-	73.7	41.2	10.6	4.1	-	-	-
		3	24.8	0.5	2.9	0.5	77.5	29.2	1.1	0.2	-	-	0.1
Cape Cockburn	10	1	4.9	0.4	1.0	0.1	32.2	39.0	1.0	4.0	-	-	-
		3	10.8	19.4	-	29.7	6.5	17.4	-	0.5	-	-	-
Secret Cove	11	1	9.7	0.1	-	0.1	83.0	3.7	6.7	3.0	-	-	-
		3	49.9	-	-	-	156.2	51.8	4.1	0.1	-	-	-
Totals			355.5	21.0	84.3	99.9	1472.0	362.2	85.3	460.1	36.3	0.1	0.2